9 SUMMARY

This thesis has examined the issue of command generation for flexible systems. The importance of the command signal has been demonstrated for a variety of systems and applications. Numerous tools for designing and evaluating command signals have been developed and demonstrated throughout the text.

Robust methods of filtering command signals in real time were developed. These filtering methods allow specification of the robustness to modeling errors. Techniques for applying these methods to multi-mode systems were developed. Furthermore, time lag introduced by the filtering process was reduced by using negative filter coefficients. Many of the proposed filtering schemes were implemented on industrial machines and shown to work very effectively.

Techniques for generating multi-switch bang-bang commands were developed. These commands provide very rapid motion. Because these commands tend to be very sensitive to modeling errors, methods for specifying the robustness were developed. This work was extended by examining the problem of generating on-off commands. Commands of this type can have periods of coasting as well as periods of full positive and full negative actuator effort. Fuel-efficient on-off commands were developed and shown to be nearly time-optimal. Methods for precisely specifying the fuel usage were also presented. On-off commands that limit the transient deflection to a desired level were developed and shown to be effective with nonlinear simulations of flexible spacecraft.

Because multi-switch bang-bang commands and on-off commands can be difficult to implement, methods for facilitating their use were examined. One method attempted to describe the command profiles by simply closed-form equations. Another method used neural networks to generate the command in real time.

Given the great variety of command generation techniques described in this thesis and in the literature, the need for head-to-head comparisons arises. Several comparisons were presented. Real-time filtering methods were compared to time-optimal commands for single and multi-mode systems. The new filtering methods developed in this thesis were also compared to more traditional FIR and IIR filtering methods.

Although commands were generated to meet a large variety of performance specifications, there are some specifications that proved too difficult to incorporate into the design process. The effect of command generation schemes on these complex performance specifications was examined. In particular, it was shown that the real-time filtering methods presented in this thesis improve the repeatability of coordinate measuring machines. Furthermore, they improve trajectory tracking and aid in obstacle avoidance.

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